Fact Sheet:

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Enhanced Surface Coatings By Ion-Plating

The Problem

Most material failures begin on the surface because of corrosion, wear, and fatigue. One way to control surface-initiated failures in metals is by alloying or changing the chemical composition throughout the material to modify the hardness, chemical passivity, electrical conductivity, or strength. However, this is a costly and inefficient use of strategic alloying materials such as cobalt, chromium, and nickel.

The Technology

A more cost-effective way to prevent surface-initiated failures is simply to deposit corrosion- or wear-resistant materials on the surface of susceptible structures. Some techniques that currently are available for this include electroplating, plasma-flame/arc spraying, and physical vapor deposition.

The U.S. Army Construction Engineering Research Laboratories (CERL) is investigating an innovative technique called ion-plating that deposits alloying materials on material surfaces. CERL research proved that ion-plating technology can be used effectively for applying coatings to several structures, including anodes used in cathodic protection systems and gaskets used on communications shelters.

Ion-plating, which originally was developed by D.M. Mattox in 1963, incorporates characteristics of two other technologies, sputter etching and ion-beam mixing. In ion-plating, the item to be coated and the source of the coating material are held in a vacuum chamber within a low-pressure gaseous environment.

Prior to being coated with the source material, the item is "sputter cleaned." Energetic inert gas ions (electrically charged atoms) strike the surface of the item to remove contaminants. Sputter cleaning is critical in ion plating because it produces a very reactive and atomically clean surface. The coating material is then evaporated, enhanced by interaction with energetic inert gas (or reactive gas) atoms and ions, and deposited on the surface of the item.

Benefits/Savings

Ion-plating offers several advantages over other available surface coating techniques. The process can be used to deposit a variety of coatings -- metals, metal alloys, ceramics, and metal/ceramic composites. It provides excellent adhesion between the coating and the surface.

Ion-plating also provides a coating with a relatively uniform thickness over the entire surface of the specimen. A uniform coating can even be applied to irregularly shaped items without extensive manipulation. Finally, ion-plating requires little or no heating of the item to be coated.

Some of the specific Department of Defense applications of ion-plating include: 1) mixed-metal, oxide-coated anodes for use in impressed current cathodic protection; 2) corrosion-resistant, electrically conductive coatings for gaskets and improved corrosion-resistant coatings for compressor blades of gas turbine engines; 3) hermetic coatings for optical fibers and devices; 4) barrier layers for semi-conductor devices; 5) fabrication of thin film thermocouples for monitoring engine performance and laser applications; and 6) nitrides of transition metals for electromagnetic shielding applications.

Status

The CERL ion-plater is operational. Current research includes investigation of the nitrides of the transition metals titanium, zirconium, and hafnium. CERL holds a

patent for "Mixed Metal Oxide Coated Substrates" for its earlier ion-plating research program.

Points of Contact

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